III. SURFACE WATER ASSESSMENT

E. LAKE WATER QUALITY ASSESSMENT

1. Designated Use Support

Eighty percent (16,742 acres) of the 20,917 lake acres in Rhode Island, at a scale of 1:24,000, have been reviewed for this report. Of the 16,742 lake acres assessed, approximately 68% (11,331.5 acres) are considered monitored and approximately 32% (5,410.76 acres) are considered evaluated. Table 3E-1 presents a summary of the degree of use support and the lake acres that are monitored and evaluated. Of the 16,581 acres assessed, 78% (13,042.6 acres) fully support all designated uses and 0.03% (<5 acres) of the lake acres fully support all designated uses but are considered threatened. Approximately 22% (3,695 acres) of the lake acres assessed do not support their uses and are considered impaired for one or more uses.

Table 3E-2 shows that data was available to assess 14,723 acres for swimming use support. The data indicated that most lake acres fully support their swimming use (95%, 13,931 lake acres). Approximately 5% (791 acres) of lake acres assessed are considered impaired for the swimming use.

Data was available to assess 15,663 lake acres for aquatic life use support. Approximately 80% of the lake acres assessed (12,514 acres) fully support aquatic life needs. Approximately 20% (3,209 acres) of lake acres assessed are impaired for aquatic life uses.

The RI Department of Health has issued an advisory against eating fish from four ponds in the state. These four ponds, which total 503 acres, are considered impaired for fish consumption use.

Forty-two (42) lakes assessed are used as drinking water supply sources. This represents 7,813 acres associated with the drinking water supply systems. Of these 7,813 acres, 5,484 acres (70%) are considered assessed for drinking water use for this report. The remaining 2,329 lake acres, or 30% were considered not assessed for drinking water use support. In general these 2,329 acres represent portions of the drinking water supply system that are upstream of the terminal reservoir. The terminal reservoir is the location within the drinking water supply system where the Department Of Health requires water samples to be collected. Some of these upstream waters are not monitored and are therefore, considered unassessed for drinking water use in this report. Ninety-nine percent (5,424 acres) of the drinking water supply lake acres assessed were found to be fully supporting, and less than 1% (<5 acres) of the drinking water supply lake acres assessed fully support uses but are threatened. Approximately 1% (55 acres) of drinking water supply lake acres assessed are considered impaired for the drinking water use.

Table 3E-1 Summary of Fully Supporting, Threatened, and Impaired Lakes (Acres)

Degree of Use Support	Assessment Category		Total Assessed Size
	Evaluated	Monitored	
Size Fully Supporting All Assessed Uses	4,632.69	8,409.86	13,042.55
Size Fully supporting All Assessed Uses but Threatened for at Least One Use	0	4.54	4.54
Size Impaired for One or More Uses	778.07	2917.08	3,695.15
Size Not Attainable for Any Use and Not Included in the Line Items Above	0	0	0
TOTAL ASSESSED	5,410.76	11,331.48	16,742.24

Table 3E-2 Individual Use Support Assessment Summary for Lakes (Acres)

USE	Size Assessed	Size Fully Supporting	Size Fully Supporting but Threatened	Size Partially Supporting	Size Not Supporting
AQUATIC LIFE SUPPORT	15,662.98	12,513.82	0	2,411.95	737.21
DRINKING WATER SUPPLY	5,483.97	5,424.46	4.54	54.97	0
FISH CONSUMPTION	502.93	0	0	0	502.93
SWIMMABLE	14,722.60	13,931.30	0	164.61	626.69

2. Causes and Sources of Impairment of Designated Use

Causes and sources for assessed waters that do not fully support their designated uses were determined and are listed in Tables 3E-3 and 3E-4, respectively, according to the EPA guidance. Causes are those pollutants or other stressors that contribute to the actual or threatened impairment of designated uses in a waterbody. Sources are the facilities or activities that contribute pollutants or stressors, resulting in impairment of designated uses in a waterbody. In general, the actual sources of impairment are not determined until a TMDL (total maximum daily load) is conducted on the waterbody. As such, most of the sources noted are just potential sources. If the waterbody-specific information indicated impact on designated use as being high, it is indicated under the "major impact" column on the tables below. If impact was listed as moderate it is listed here under "moderate" impact.

The “aging” process (eutrophication) is a natural process in the life of all freshwater lakes and ponds, but is often accelerated by human-related development in the watershed. Rapid eutrophication, with high inputs of nutrients and associated heavy algal blooms or bottom weed growth, eventually severely limit desirable recreational uses and result in low dissolved oxygen problems which limits the aquatic life uses.

As shown in Table 3E-3, the major causes of impairment for lakes are from nutrients, low dissolved oxygen and pathogens. Another major cause of non-support in terms of total acreage effected, is from metals. This major cause of impairment applies only to 12 lakes, many of which are large in size and, therefore, account for the large number of acres affected by metals.

In the majority of cases there is not enough information to link the causes of impairment to a source of the pollutant. Potential sources of nonsupport are shown in Table 3E-4. The major potential sources of impairment are from urban runoff/storm sewers and land disposal, including onsite wastewater systems and landfills. Overall the sources of pollution are from nonpoint sources which can supply high nutrient inputs that cause algal blooms, low dissolved oxygen and severe eutrophication problems.

Table 3E-3 Total Size of Waters Impaired by Various Cause/Stressor Categories
Lakes (acres)

Cause/Stressor Category	Size of Waters by Contribution to Impairment	
	Major	Moderate
BIODIVERSITY IMPACTS	37.97	537.82
EXCESS ALGAL GROWTH/CHL-A	67.41	1399.20
EXOTIC SPECIES		219.37
METALS	607.78	620.38
NOXIOUS AQUATIC PLANTS native		297.61
NUTRIENTS	138.68	1898.57
LOW DO	209.93	1257.30
PATHOGENS	80.75	710.55
CHLORIDES		26.26
SILTATION		108.97
SUSPENDED SOLIDS		26.26
TASTE AND ODOR		54.97
TURBIDITY		121.70

TABLE 3E-4 Total Sizes of Waters Impaired by Various Source Categories
Lakes (acres)

Source Category	Contribution to Impairment	
	Major	Moderate
AGRICULTURE		715.5
ATMOSPHERIC DEPOSITION		33.2
COMBINED SEWER OVERFLOW		38.0
CONSTRUCTION		143.4
GROUNDWATER LOADINGS		201.7
HABITAT MODIFICATION (other than hydromodification)		66.1
HYDROMODIFICATION		609.5
INDUSTRIAL POINT SOURCES		130.3
INTENSIVE ANIMAL FEEDING OPERATIONS		480.1
INTERNAL NUTRIENT CYCLING (primarily lakes)		224.4
LAND DISPOSAL		1230.5
MUNICIPAL POINT SOURCES		252.8
NATURAL SOURCES	76.8	257.0
RECREATIONAL AND TOURISM ACTIVITIES (non-boating)		308.0
SOURCE UNKNOWN	379.4	410.0
URBAN RUNOFF/STORM SEWERS	29.4	2176.2

3. Clean Lakes Program

a. National Program - Background

The Clean Lakes Program was established in 1972, under the Federal Water Pollution Control Act, to provide financial and technical assistance to the States in restoring publicly-owned lakes. The early focus of the program was on research, development of lake restoration techniques, and evaluation on conditions (Lake Classification Studies). The Clean Lakes Program Regulations promulgated in 1980, redirected program activities to diagnose the current condition of individual lakes and their watersheds, determine the extent and sources of pollution, develop feasible lake restoration and protection plans (Phase I Diagnostic/Feasibility Studies) and to implement these plans (Phase II Restoration/Protection Implementation Projects).

With the passage of the 1987 Amendments to the Clean Water Act, EPA expanded the program to include Statewide assessments of lake conditions (Lake Water Quality Assessment grants). EPA also established Phase III Post-Implementation Monitoring studies to evaluate the longevity and effectiveness of various restoration and protection techniques implemented under Phase II grants. Unfortunately, Federal funding of the Clean Lakes Program ended with FY94 funds.

b. Rhode Island Program - Background

The State of Rhode Island does not have a formal comprehensive lakes-management program. The primary protection is provided by the RIDEM Water Quality Regulations; Best Management Practices such as buffers and setbacks required under RIDEM Wetlands Regulations; and Individual Septic Disposal System regulations. A small number of local (municipal) stormwater and/or nutrient loading ordinances exist at this time.

The RIDEM Nonpoint Source Pollution Management Plan is attempting to deal with control of NPS to all waterbodies, including lakes and ponds through educational outreach workshops, etc. Nonpoint (319) Federal funds are potentially available for implementation of some BMP's through the NPS Management Program if matching funds are available.

A list of publicly owned lakes in Rhode Island is presented in Table 3E-5 in fulfillment of Section 314 of the Clean Water Act of 1987. These lakes are considered to have legal public access, and are open to the general public or town citizenry for the recreational use(s) indicated. Lakes with privately-owned or for-profit access (e.g., private beaches, marinas, etc.), are not listed here. Therefore, this list should *not* be interpreted as a list of all Rhode Island recreational lake opportunities available to the general public. At present, there are 88 such public lakes, covering a total surface area of approximately 8,763 acres which have been assessed for this report.

Before 1988, RIDEM had only extremely limited, or, more often, no information on water quality in most Rhode Island lakes and ponds. In order to rectify this situation, and to provide some minimal baseline data for water quality assessments, the RIDEM Division of Water Resources water quality planning section developed a limited baseline sampling contract with the U.S.G.S. for 1988 and 1989. Thirty-five (35) lakes/ponds were sampled once during summer stratification/bloom period (August), and again during fall overturn (October-November) over this two (2) year period. The list of lakes sampled, as well as water quality data results are available in the RIDEM 1990 305(b) report.

At the same time this sampling program was developing, the USEPA announced the availability of Federal grant money for Statewide assessments of lake water quality. Through the help and cooperation of the University faculty associated with the University of Rhode Island Water Resources Center, a successful grant application for these funds was developed. Funding was received in 1989 for a two (2) year (1989-1990) study by the URI Department of Natural Resources Science of 34 public lakes in the southern half of Rhode Island.

Using the data from these two (2) lake monitoring projects, RIDEM initiated the development of lake assessments for significant publicly-owned lakes in the 1990 305(b) report. From 1991 to 1994 (the last year of Federal Clean Lakes funding), RIDEM received Clean Lakes, Lake Water Quality Assessment grants and developed cooperative agreements with the URI Cooperative Extension Watershed Watch Program, to continue the water quality monitoring and assessment of public lakes in Rhode Island. Annual reports summarizing the results of monitoring for each Watershed Watch lake are available from RIDEM, OWR. From 1995 to 1999, the URI Watershed Watch program secured other funding to continue lake monitoring but continued to share that data with DEM to allow for the continuation of lake assessments in Rhode Island. As of 1999, DEM was able to resume funding to the Watershed Watch program and is currently working under a multiyear agreement with URI to ensure the continuation of funding for this program and an increase in the number of lakes monitored each year.

Table 3E-5. State of Rhode Island - 2004 Use Assessment for Publicly-Owned Lakes

Lake	Size (Acres)	Trophic Class	Water Quality Class	Access/Use	Impairment/Cause
Burrillville					
Wakefield Pond	75.073	O	B	SBLR*/WWF	
Wilson Reservoir	109.31	O	B	SBLR/WWF	
Pascoag Reservoir (Echo Lake)	349.07	O	B	SBLR/WWF	
Round Top State	9.7211	U	A	SFA/STK(B)	
Spring Lake	94.803	O	B	SBLR/TBH	
Wallum Lake (RI waters)	172.79	O	A	SMA*/SBLR(MA)/CWF/ STK(A)	
Slatersville Reservoir	218.87	M	B	SFA/WWF	PS - Nutrients;Pathogens NS - Metals
Peck Pond	13.415	U	B	SMA/SP*/SBH/ STK(B)/WWF	
Barrington					
Echo Lake	24.393	U	B		
Prince's Pond (Tiffany Pond)	8.0787	H	A		NS - Nutrients, Low DO, Excess algal growth
Brickyard Pond	84.062	M	B	TFA/WWF/STK(C)	PS-Low DO
Charlestown					
Watchaug Pond	567.92	M	B	SBLR/SP/SBH/ STK(B)/SMB/WWF	
Coventry					
Carbuncle Pond	38.924	M	A	SMA/STK(B)/WWF	
Coventry Res. (Stump Pond)	168	O	B	SP/WWF	
Flat River Res. (Johnson Pond)	647.14	M/O	B	BLR/WWF	
Upper Dam Pond	20.488	E	B		PS-Nutrients
Tiogue Lake	233.9	O	B	SBLR/TBH/WWF/ SMBSP/WWF	
Waterman Pond (Sisson Pond)	32.344	U	A		

Table 3E.-5. Cont'd

Lake	Size (Acres)	Trophic Class	Water Quality Class	Access/Use	Impairment/Cause
Cranston					
Meshanticut Pond	12.287	U	B	SP/WWF	
Randall Pond	34.439	M	B	WWF	
Spectacle Pond	38.807	E	B	WWF	PS-Nutrients,Excess algal growth
J.L. Curran Res. (Fiskeville Res.)	46.228	M/O	B	SP/SBLR/WWF	
Cumberland					
Valley Falls Pond	37.969	E	B1		NS- Biodiversity impacts, Nutrients, Low DO, Metals, Pathogens, Excess algal growth
East Providence					
Turner Reservoir (North & South)	214.783	E	B1/B		NS - Nutrients, Low DO, Pathogens, Metals
Exeter					
Beach Pond	142.74	O	B	SMA/SBLR/SBH/STK(A)	
Arcadia Pond (Browning Mill Pond)	50.025	O	B	SMA/SBH	
Deep Pond	2.4385	M/E	A	SMA/STK(A)	PS-Low DO, Nutrients
Foster					
Shippee Saw Mill Pond	8.1869	M	A	SBLR/STK(A)	
Glocester					
Bowdish Reservoir	219.37	O	B	SMA/SBLR/SBH/WWF	PS-Exotic Species
Burlingame Reservoir	67.243	U	B		
Clarksville Pond	15.026	U	B	SFA/SBLR	
Keech Pond	49.245	O	B	SBLR/WWF	
Ponagansett Reservoir	219.98	U	A	WWF	
Smith & Sayles Reservoir	172.74	O	B	SBLR/WWF	
Lake Washington	40.887	M	B	SBLR/WWF	
Waterman Reservoir	251.86	M	B	WWF	

Table 3E-5. Cont'd

Lake	Size (Acres)	Trophic Class	Water Quality Class	Access/Use	Impairment/Cause
Hopkinton					
Long Pond	20.194	O	B	SMA/WWF	
Ashville Pond	25.678	U	B	SMA/STK(B)/WWF/SMB	
Ell Pond	4.8953	U	B		
Wyoming Pond	34.051	M	B	SBLR/STK(A)/WWF	
Alton Pond	44.209	M	B	SBLR/STK(A)/WWF	
Blue Pond	93.931	U	B	SBLR/WWF	
Locustville Pond	82.304	M	B	SBLR/SFA/WWF	
Moscow Pond	16.48	M	B	SFA/WWF	
Johnston					
Oak Swamp Reservoir	109.36	O	B		
Almy Reservoir	52.928	M	B		
Lincoln					
Olney Pond	129.03	M	B	SP/SBLR/STK(A)/SBH/ WWF	
Scott Pond	42.127	E	B		PS – Low DO, Excess algal growth, Nutrients
Handy Pond	8.0583	E	B	SFA	
Barney Pond	23.843	E	B	TFA/SP	PS - Nutrients
Newport					
Almy Pond	49.85	H	A		NS - Nutrients
North Kingstown					
Silver Spring Lake	18.747	M	B	SBLR/STK(A)/WWF	
Potowomut Pond	18.673	U	B	SFA	
Belleville Ponds	130.27	M	B	BLR(TOWN)/WWF	PS-Nutrients
Secret Lake	46.213	M	B	TFA/WWF	
Annaquatucket Mill Pond	6.3045	M	B	Alewife run/WWF	
North Providence					
Wenscott Reservoir (Twin Rivers)	82.823	M	B	TBH/WWF	

Table 3E-5. Cont'd

Lake	Size (Acres)	Trophic Class	Water Quality Class	Access/Use	Impairment/Cause
North Smithfield					
Tarkiln Pond	23	U	B	TFA/STK	
New Shoreham					
Sachem Pond	79.925	U	A		
Pawtucket					
Slater Park Pond	21.357	H	B1	TFA/STK	NS-Nutrients, Pathogens, Excess algal growth
Portsmouth					
Saint Mary's Pond	112.06	U	A	SFA/STK	PS - Biodiversity impacts
Providence					
Roger Williams Park Ponds	88.582	H	B	CITY PARK	PS- Low DO, Nutrients, Excess algal growth, Pathogens
Mashapaug Pond	76.746	E	B	SBLR/WWF	PS-Nutrients, Low DO, Excess algal growth
Richmond					
Carolina Trout Pond	3.3039	M	A	SMA/STK(A)/WWF	
Meadowbrook Pond	23.063	M/E	A	SFA/STK(A)	NS-Metals
South Kingstown					
Worden Pond	1,051.2	M	B	SBLR/WWF	
Barber Pond	28.159	M	B	SBLR/STK(B)/WWF	PS-Low DO
Asa Pond	23.848	U	B		
Glen Rock Reservoir	30.251	M	B	WWF	
Silver Lake	44.783	O	B		
Peace Dale Reservoir	11.707	U	B		
Tucker Pond	92.968	M	B	SBLRSTK(C)/WWF	
Smithfield					
Mountaindale Reservoir	10.421	U	B		
Slack Reservoir	133.61	M	B	TBH/WWF/SMB	
Woonasquatucket Res. (Stump Pond)	302.84	M	B	TFA	

Table 3E-5. Cont'd

Lake	Size (Acres)	Trophic Class	Water Quality Class	Access/Use	Impairment/Cause
Stillwater Pond	15.046	M	B		
Georgiaville Pond	96.907	M	B	TBH/WWF	
Tiverton					
Stafford Pond	480.13	M/E	A	SBLR/STK(A)/WWF/SMB	PS-Excess algal growth, Nutrients, Low DO
Warwick					
Sandy Pond, (Little Pond)	28.342	M	B	TBH	PS - Pathogens
Sand Pond (N. of Airport)	12.209	M	A	TBH	PS - Low DO, Nutrients
Gorton Pond	58.3	M	B	TBH/WWF/TOWN PARK	PS - Excess algal growth, Nutrients, NS - Low DO
Posnegansett Pond	13.349	M	A	TBH	
Warwick Pond	84.716	E	B	TBH	PS-Nutrients, Excess algal growth, Low DO
Westerly					
Chapman Pond	172.77	M	B		PS-Metals, Noxious aquatic plants
West Greenwich					
Breakheart Pond	43.792	O	A	SFA/STK/SBLR/WWF	
Mishnock Lake	47.029	O	B	TFA/WWF	
Tarbox Pond	19.902	M	A	SFA	

KEY for Table 3E-5:

SBH = State Beach

SBLR = State Boat Launching Ramp

SFA = State Fishing Access

SMA = State Mgt. Area

TFA = Town Fishing Access

SP = State Park

SMB = Small mouthed bass

@ = abundant bottom vegetation

. = F&W Priority List

TH = Threatened

PS = Partially Supporting

NS = Not Supporting

WWF = Warm Water Fishery

TBH = Town or City Beach

STK = Stocked Trout (A) = High fishing usage; (B) = Lower fishing usage; (C) = Low usage/Less suitable habitat

TROPHIC CLASSES: O = Oligotrophic; E = Eutrophic; H = Hypereutrophic;   M = Mesotrophic; D = Dystrophic

4. Trophic Status

In addition to use support assessments, RIDEM assesses the trophic status of lakes. Table 3E-5 summarizes the trophic status of the public lakes and ponds that were assessed for this report. The data and determination of trophic status for the public lakes comes from the Watershed Watch monitoring program. The trophic status of lakes is based on the Carlson Index for chlorophyll a, secchi depth, and phosphorous using the following:

Water Quality Measurement or Term	**Oligotrophic** Low Nutrient enrichment	**Mesotrophic** Average Nutrient enrichment	**Eutrophic** Above average nutrient enrichment
Secchi Depth Transparency	greater than 4 meters greater than 13 feet	2 - 4 meters 6.3 - 13 feet	less than 2 meters less than 6.3 feet
Chlorophyll Content	less than 2.6 ppb	2.6 - 7.2 ppb	more than 7.2 ppb
Phosphorus Content	less than 12 ppb	12 - 24 ppb	more than 24 ppb
Trophic State Index	less than 40	40 - 50	more than 50

It should be kept in mind that trophic status can be very dynamic, with parameters such as secchi and chlorophyll altering rapidly (within weeks or less). With the extensive monitoring data from the Watershed Watch program, 136 lakes, representing 16,742 acres, are considered assessed for the 2004 305(b) assessments.

A summary of the number of lakes classified within each trophic group for public lakes is shown in Table 3E-6 and for private lakes in Table 3E-7. There are 31 lakes within the current database for which we do not have access or trophic status information. It is obvious from Tables 3E-6 and 3E-7 that the majority of Rhode Island lakes fall into the mesotrophic classification range. The specific trophic classification for each public lake, as well as size, use classification, public access, and use impairment (if any), are provided in Table 3E-5.

Table 3E-6 Summary of trophic status for Rhode Island Public Lakes/Ponds 2004

Trophic Status	Number of Lakes	Acreage of Lakes
Oligotrophic	17	2102.24
Meso/Oligo	2	693.36
Mesotrophic	34	3,947.63
Meso/Eutrophic	3	505.63
Eutrophic	10	547.54
Hypereutrophic	4	167.87
Unknown	18	798.54
Total Number of Lakes	88	8,762.81

Table 3E-7 Summary of trophic status for Rhode Island Private Lakes/Ponds 2004

Trophic Status	Number of Lakes	Acreage of Lakes
Oligotrophic	9	583.15
Oligo/Meso	1	45.64
Mesotrophic	11	1009.40
Eutrophic	3	174.77
Unknown	58	7288.79
Total Number of Lakes	82	9,101.75

5. Control Methods and Restoration/Protection Efforts

a. General

Although Rhode Island does not have a formal comprehensive lake management program, lakes are protected by the RIDEM Water Quality Regulations; Best Management Practices required by RIDEM Wetlands Regulations; and Individual Septic Disposal System Regulations. A small number of local stormwater and/or nutrient loading ordinances exist at this time. In addition, the Rhode Island Water Quality Regulations contain a total phosphorous limit of 0.025 mg/l in any lake or pond. The Regulations also include a narrative limitation on the allowable concentration of nutrients so as not to cause undesirable or nuisance aquatic species associated with cultural eutrophication. Direct point source discharges to lakes are practically nonexistent in Rhode Island.

In the late 1980's and early 1990's, RIDEM received Federal 314 Clean Lakes grants to conduct Demonstration and Phase I Diagnostic/Feasibility Studies on several lakes in Rhode Island. Unfortunately the state and local matching funds requirement of these grants precluded RIDEM's ability to solicit further funds under this program.

The RIDEM Nonpoint Source (NPS) Pollution Management Plan is attempting to deal with control of NPS to all waterbodies; including lakes and ponds, through educational outreach workshops, etc. Nonpoint Federal funds (Section 319) are potentially available for implementation of some BMPs through the NPS Management Program. Below are descriptions of two recent projects conducted using Nonpoint funds.

b. *Stafford Pond Project*

Stafford Pond is a 480 acre water body located in Tiverton, R.I. which serves as a drinking water supply for residents of Tiverton and Portsmouth, R.I. Over the past several years, the pond has experienced frequent algal blooms, leading to taste and odor problems and prompting the Stone bridge Fire District to upgrade its water treatment practices.

In 1995, RIDEM awarded $107,000 of a State Nonpoint Source grant to Fugro East, Inc. to conduct an in-depth limnological investigation of the pond. The goals of the study were to assess the water quality of the pond and its tributaries, identify pollution sources, and develop cost-effective solutions for controlling pollution problems.

The study was completed in 1996 and the final report was submitted to RIDEM in the summer of 1997. The results clearly indicate that algal blooms are a result of high phosphorus loadings, principally coming from a local dairy farm. Additional sources include residential land uses and storm drains. In coordination with the Natural Resources Conservation Service, the Nonpoint Source Program has provided funds for follow-up BMPs. BMPs have been developed for the farm in order to reduce the loadings of phosphorus into the pond. In addition, BMPs are being developed to address two state-owned storm drains. Once all primary watershed contributions have been addressed, some form of in-lake treatment may be undertaken to eliminate the high phosphorus levels that have built-up in the pond over time.

c. *Watchaug Pond Project*

Watchaug Pond is located in Charlestown, RI and is bordered on the south, west and north by Burlingame State Park. The pond is considered to have highly valuable recreational and habitat resources. At the start of this project, nutrients, sediment and oil degraded water quality in the pond, threatening to turn its condition eutrophic. Nonpoint pollution from state-owned property was documented by a clean lakes study to include sources in the Burlingame Main Camp Beach area, Burlingame picnic area and Burlingame camping area. This project addressed runoff from roads, parking lots and other surfaced parts of the Burlingame camping and picnic areas.

Construction in this project consisted of two parts – the picnic area and the Main Camp Beach area. Prior to this project, the parking lot at the picnic area was oiled dirt and rain events would drain oily runoff from this surface down an access road directly to the pond. Construction included the paving of the parking area and installation of a number of drains, improvements to existing pipes and the installation of two underground catch basins and a rip-rapped drainage area at the base of the hill. Concrete and asphalt berms direct any overland runoff from the parking lot down the hill to a drain and into the catch basin. Since construction, the amount of sediment and oiled material reaching Watchaug Pond from the parking area is greatly diminished.

The Main Camp Beach area is in the oldest part of Burlingame State Park. The area consists of 90 wooded campsites, which slope downhill toward the beach. DEM Park staff stated that drainage in this area was extremely poor and, prior to the project, runoff caused substantial erosion of soil, nutrients and litter into Watchaug Pond. Construction throughout the Main Camp Beach area consisted of the installation of asphalt berms to direct runoff to 5 dry wells and 4 inground pipe and berm systems, which direct runoff to rip-rap lined swales. Park maintenance staff are deployed following rain events to make sure that the drain grates are cleared of any debris. DEM Park staff stated that the construction has substantially reduced runoff into the pond.

d. Clean Lakes Assessment Projects

The RIDEM has been awarded Federal Clean Lakes grants since 1988. Federal funding of the Clean Lakes Program ended, however in 1994. Table 3E-8 summarizes the description and type of Clean Lakes Projects that have been undertaken and/or completed by RIDEM. Below is a more detailed description of the Clean Lakes Statewide Assessment Projects.

i. QA/QC Project - A Statewide Lake Assessment grant to increase Quality Assurance/Quality Control for the URI-led Watershed Watch volunteer lake monitoring program, was received in 1991. URI provided the required 50% State match. The objective of this project was to create a permanent QA/QC program for volunteer monitoring of water quality in lakes with public access in the State. An Advanced Training for Water Quality Monitors program was developed with an academic (classroom and field laboratory) stage and a QA/QC monitoring stage. The project had hoped to add 10 publicly-owned lakes to those already monitored under the Watershed Watch program, utilizing members of the Bass Anglers Sportmen's Society (BASS). Overall, four to five (4-5) out of those additional 10 lakes were monitored sufficiently to calculate seasonal means and trophic status. Monitored parameters for this project included secchi depth (weekly); dissolved oxygen and chlorophyll a (bi-weekly); and pH, alkalinity, Na + Cl, Ca + Mg, total phosphorous and nitrogen, total solids and E. coli on a tri-seasonal basis.

ii. Data Management Project - The RIDEM, Office of Water Resources, (OWR) received a Clean Lakes Assessment grant in 1992 to develop and implement a data management system to store and analyze lake water quality monitoring data. The purpose of this data management system is to support the USEPA's Water Body System (WBS) by providing summaries of raw monitoring data from which assessments of the overall health of the lake can be developed. OWR staff developed a Microsoft Access water quality database to house the raw water quality data and a MS Access WBS database to maintain the assessment information.

iii. Macrophytes Project - The RIDEM, Office of Water Resources (OWR), in cooperation with URI's Watershed Watch Program, received a Lake Water Quality Assessment grant in 1993. There were three (3) primary goals for this grant:

- to actively recruit organizations interested in water quality monitoring in public lakes;
- to expand the number of public lakes monitored by volunteers in the Rhode Island Watershed Watch program; and
- to initiate monitoring of rooted aquatic plants in public lakes by volunteers to improve trophic status classifications.

To actively recruit organizations interested in monitoring lake water quality, the Watershed Watch Program held a day-long conference. The overall goal of the conference was public education as well as to increase participation, in terms of both numbers of volunteers and of public lakes, in the URI Watershed Watch Program. Over 80 people attended the conference and nearly 60 individuals signed up for a field training session, with the majority actually attending one of the sessions. This conference was so successful, both for recruitment and as an educational platform, that it was decided to continue it on an annual basis.

A goal of a 40% increase in the number of public lakes monitored by URIWW volunteers was set. The lakes to be targeted for monitoring were determined through consultation with RIDEM, OWR staff. To guide the selection process the OWR developed a list of public lakes with presumed accessibility by boat or canoe. The choice of these locations was based upon OWR's 1991 Priority List for Lake Assessment. Final lake selection was determined by successful recruitment and training of volunteers. Volunteers were successfully recruited for, and trained to monitor 17 additional public lakes. This represented an increase of nearly 50% over the number of public lakes in the program in 1992.

A six session program to train volunteers to identify and delineate freshwater aquatic macrophytes was developed. The curriculum was designed to provide participants with the skills necessary to complete aquatic plant surveys while teaching basic macrophyte ecology. An aquatic plant survey manual, pictorial guide and key to common freshwater aquatic plants of Rhode Island and other resource materials were developed for use in the training program. The goal of the course was to enable volunteers to map the type and distribution of aquatic plants on the lakes they monitor.

iv. Dissolved Oxygen Project- The RIDEM, Office of Water Resources, in conjunction with URI's Watershed Watch Program, received a 1994 Clean Lakes Water Quality Assessment grant. The primary goals of the project were:

- to train volunteers to obtain dissolved oxygen profiles on RI Watershed Watch public lakes with depths greater than five (5) meters;
- expand volunteer monitoring of public lakes and ponds and of incoming tributaries to public lakes and ponds currently in the RI Watershed Watch program;
- to delineate and digitize sub-watershed boundaries for RI Watershed Watch public access lakes; and
- to work with volunteers and local lake and watershed organizations to initiate a series of watershed-based public education materials (brochures) which integrate RI Watershed Watch lake and tributary data (and water quality data from other sources) with locally available historical and cultural information.

Table 3E-8 Clean Lakes Program Projects

	Number of Ongoing Projects	Number of Completed Projects
Demonstration Projects		1
Phase 1 Projects		2
Phase 2 Projects		
Phase 3 Projects		
LWQA Annual grant projects		4

6. Impaired and Threatened Lakes

Of the 136 lakes and ponds assessed for this report, approximately 33% (45 lakes) are considered impaired. As noted previously, waters that are assessed as impaired under the 305(b) process are placed on the state's 303(d) List of impaired waters. Once on the 303(d) List, waters are prioritized and scheduled for TMDL work. The 45 lakes mentioned are on RI's 2004 303(d) List.

Water quality criteria for DO, metals, bacteria, and phosphorus serve as the basis for impairment determinations in the lake assessment process. The state's narrative standards are used to assess for excess algal growth, biodiversity impacts, siltation, suspended solids and taste and odor. As Tables 3E-3 and 3E-5 indicate, most lakes in RI are considered impaired due to nutrients and the associated excess algal growth and low DO conditions. Elevated pathogens, biodiversity impacts and metals are also causes of impairment in RI lakes.

Elevated nutrient levels affects 2,037 acres on 27 lakes assessed. Excess algal growth are noted in 17 lakes. These conditions affect water clarity and often recreational use of lakes and ponds. Too much algae can also have detrimental effects on aquatic ecosystems.

Low dissolved oxygen impairs 17 lakes assessed. This impairment generally shows up as hypoxic or anoxic conditions from the thermocline to the lake bottom. This low DO condition below the thermocline can often be the natural result of the shape and size of a lake. It can be difficult, therefore, to determine if the reason for the impairment is due to natural causes or anthropogenic causes which should be addressed under the TMDL program. Landuse information and best professional judgement from the Watershed Watch staff assists with these assessment decisions.

7. Acid Effects on Lakes

In the late 1970's and early 1980's as concern about surface water acidification and its effects on fish populations increased, the Rhode Island Division of Fish and Wildlife initiated a study to develop an inventory of lake and stream buffering capacities to determine which waters were most susceptible to acidification. This study continued between 1983 and 1986 where the RIDEM, Division of Fish, Wildlife and Estuarine Research sampled 78 lakes and ponds as well as 42 streams for pH and alkalinity. This study is reported in the 1987 RI Division of Fish and Wildlife, Fisheries Report No. 8, "A survey of Rhode Island surface water pH and alkalinity." The purpose of this study was to determine the general fish habitat suitability in surface waters in Rhode Island, based upon current pH levels and to establish a baseline inventory of pH and alkalinity data. It became clear from this study that many freshwater ponds and lakes located in the western part of the state, in the central area of Conanicut Island, and in the eastern parts of Tiverton and Little Compton are highly susceptible to acidification due to the poor buffering capacity (<2.5 mg $CaCO_3$/l) of these regions. The geology of these areas is dominated by poorly buffering granitic bedrock.

A 5 year follow-up study was initiated in 1988 to measure changes in pH and total alkalinity over time in 10 selected low alkalinity lakes and ponds and to investigate any corresponding changes in fish populations. The data from this report is summarized in Lapin, W.J., Acidification Monitoring, December 1996, Project #F-20-R-37. All ten sites showed a slight increase in pH over the course of the study from a mean of 5.298 pH units to a mean of 5.625 pH units. Total alkalinity increased in 9 of the 10 sites over the study period from a mean of 0.069 mg $CaCO_3$/l to a mean of 0.478 mg $CaCO_3$/l. All of the sites displayed a typical seasonal pattern of high summer pH and alkalinity and lower winter values. Since the lakes and ponds monitored in the study were among those found to be most susceptible to acidification, it was determined that no significant increase in surface water acidification took place in any Rhode Island lakes and ponds during the study period. In addition, several species of fish were abundant in each of the lakes and ponds studied and, therefore, it was surmised that acidification of Rhode Island lakes does not appear to pose any immediate threat to any of the state's freshwater fish populations.

To continue the evaluation of lake acidification in RI lakes, the URI Watershed Watch Program collects data on pH and alkalinity in the lakes monitored under their program. Watershed Watch uses the six EPA categories to describe the alkalinity status of lakes and ponds. In 2001-2002, two ponds fell into the acidified category (<1 mg/l $CaCO_3$) with <5 pH). There were 8 ponds that fell into the critical category (<2 mg/l $CaCO_3$) and 19 in the endangered (2-5 mg/l $CaCO_3$) category. There are 18 lakes in the highly sensitive (5-10 mg/l $CaCO_3$) category and 17 in the sensitive (10-20 mg/l $CaCO_3$) category and 18 ponds with alkalinity values greater than 20 mg/l. In general, the Watershed Watch program has not found any shifts in more than one category from year to year at any locations. Most tend to stay within the same category.

Watershed Watch also measures pH in the lakes. The normal pH range for lakes and ponds is between 6 - 9 pH units. During the 2001-2002 monitoring period, pH ranged from a low of 4.4 in a kettlehole pond in an undeveloped area to a high of 9.8 in an urban pond. The Watershed Watch Program determined that, in general, pH increases from south to north in the Watershed Watch monitoring locations; the lowest pH values are found in southern RI and the highest in northern RI. Measurements for locations with several years of data have remained extremely stable. In most cases, the areas of low acidity and poor buffering capacity correspond to areas where the bedrock geology is dominated by granitic rock, suggesting that the low acidity is at least in part a function of natural conditions in the area. A summary of the number of lakes assessed for and impacted by high acidity is presented in Table 3E-9.

Table 3E-9. Acid Effects on Lakes

	Number of Lakes	Acreage of Lakes
Assessed for Acidity	94	10,108.95
Impacted by High Acidity	0	0
Vulnerable to Acidity	0	0

8. Toxic Effects on Lakes

The main focus on lakes and ponds in RI has been centered on trophic indices, pH, bacteria levels, nutrient loading and eutrophication. Toxicity measurements and impairments due to toxics are not evaluated on a regular basis in RI lakes and ponds. Twelve ponds are considered impaired for metals and are listed on the 303(d) List. Seven of these ponds are impoundments along rivers in urban areas.

9. Trends in Lake Water Quality

Although there is up to 14 years of water quality data for various public lakes and ponds in Rhode Island, there does not appear to be a statewide or watershed-wide trend in lake water quality over this period time. The Watershed Watch Program has stated that over the years they have at times begun to see a "trend" with three years of data in a given lake but then subsequent years' data do not follow the "trend". The appearance of any "trends" has been highly variable and weather dependent. The Watershed Watch Program's annual reports do summarize the lake-specific water quality data and, where available, note any "trends" in water quality for that lake. In general, the majority of lakes monitored by Watershed Watch fall into the stable trend category.

Although exact trends cannot be ascertained, it can be stated that many lakes in developed watersheds do exhibit impaired water quality. It can be surmised that unless proper runoff and nutrient controls are implemented, a trend of accelerated eutrophication and deterioration of water quality due to nonpoint sources of pollution will become apparent.